509Asphalt Binder Quality Management System

509.1 Purpose

509.1.1 The Asphalt Binder Quality Management System (ABQMS) provides the Utah Department of Transportation with a quality management program for Performance Graded Asphalt Binders (PGAB) by establishing qualified sources of these materials and verifying the compliance of materials shipped from these sources to paving projects with specification requirements.

The ABQMS is comprised of a Standard Practice for Certifying Suppliers of Performance Graded Asphalt Binders, a contractor's Field Quality Control of PGAB program, a PGAB Asphalt Binder Quality Assurance Plan, and a method of addressing non-specification PGAB delivered to paving projects.

509.1.2 All asphalt binder producers and/ or suppliers to UDOT paving projects must be registered by UDOT under the **Standard Practice for Certifying Suppliers of Performance Graded Asphalt Binders** as outlined under **Section 509.2.**

509.1.3 The contractor will be responsible for the **Field Quality Control of PGAB** when the binder is delivered to the mix plant, as outlined under **Section 509.3.**

509.1.4 UDOT will accept asphalt binder under its **Performance Graded Asphalt Binder Quality Assurance Plan** as outlined under **Section 509.4.**

509.1.5 Non-specification PGAB delivered to paving projects will be addressed by the **Calculation and Application of Price Reductions for Non-Specification PGAB** section as outlined under **Sections 509.5 and 509.6**.

509.2 Standard Practice for Certifying Suppliers of Performance Graded Asphalt Binders.

509.2.1 Scope

509.2.1.1 This standard specifies requirements and procedures for a certification system that is applicable to all suppliers of performance graded asphalt binders (PGAB). The requirements and procedures cover materials manufactured at refineries and/or materials.

509.2.1.2 *This standard may involve hazardous materials, operations, and equipment. It does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

509.2.2 Referenced Documents

509.2.2.1 AASHTO Standards:

M320 Specifications for Performance Graded Asphalt Binder
PP6 Practice for Grading or Verifying the Performance Grade of an Asphalt Binder

T40 Sampling Bituminous Materials
T301 Elastic Recovery Test of Bituminous Materials by means of a Ductilometer

509.2.2.2 ASTM Standards:

D8 Terminology Relating to Materials for Roads and Pavements
D5801 Toughness and Tenacity Testing Method
D3665 Practice for Random Sampling of Construction Materials

509.2.3 Terminology

509.2.3.1 *Asphalt Binder*- An asphalt based cementitious material that is produced from petroleum residue either with or without the addition of non-particulate organic modifiers to quality and consistency for direct use in the manufacture of bituminous pavements.

509.2.3.2 *ASC*- Approved Supplier Certification

509.2.3.3 *PGAB*- Performance Graded Asphalt Binder

509.2.3.4 *DSR*- Dynamic Shear Rheometer

509.2.3.5 *BBR*- Bending Beam Rheometer

509.2.3.6 *Supplier*- A supplier is defined as an individual or an entity who performs the final production, blending, or modification which alters the properties of the PGAB used in the M320 specification. A supplier could be a refinery, a terminal, or a Hot-Mix Asphalt (HMA) producer. If there is no further alteration of the PGAB after its initial production, the refinery is the supplier and must provide the certification. If there is any grade modification of the PGAB at the terminal, the terminal becomes the supplier and must provide the certification.

NOTE 1- Various refining techniques can produce asphalts of equivalent -grade. These asphalts may be incompatible with each other. Hot-mix producers should consider compatibility before combining different asphalts and/or asphalts from different sources. If different asphalts and/or asphalts from different sources are blended by the user, they become the responsibility of the Hot-mix producer.

509.2.3.7 *Agency*- The Utah Department of Transportation. UDOT's Asphalt Laboratory Engineer will be responsible for the certification of PGAB suppliers and for the final acceptance of the PGAB.

509.2.3.8 *Specification Compliance Testing*- Complete testing according to the AASHTO-M320 specification requirements. The procedure for verification of grade as described in AASHTO PP6 shall be followed.

509.2.3.9 *QC Testing*- Quality Control testing could be a subset of the M320 testing that the supplier will select and describe in his Quality Control Plan. The supplier QC plan will

have to be approved by the agency or its authorized representative.

NOTE 2- Definitions for various other terms common to asphalt binders can be found in ASTM D8.

509.2.4 **Significance and Use**

509.2.4.1 This standard specifies procedures for minimizing disruption of PGAB shipments caused by testing requirements. This is accomplished by a certification system with quality control and specification compliance tests performed by the supplier on samples obtained prior to shipment.

509.2.4.2 The number of grades available under M320 may require construction of additional storage facilities to comply with Asample and hold while testing@ procedures.

509.2.4.3 This standard provides information and guidelines on the following:

509.2.4.3.1 General requirements that the supplier must satisfy prior to achieving approved supplier status,

509.2.4.3.2 Minimum requirements that must be included in a supplier's quality control plan,

509.2.4.3.3 General requirements that the agency must satisfy prior to certification,

509.2.4.3.4 Procedural requirements for shipment of PGABs under an ASC system,

509.2.4.3.5 Procedural requirements for agency monitoring of an ASC system at the shipping facility.

509.2.5 **Sampling -** All test samples required by this standard shall be obtained in accordance with AASHTO T 40 and ASTM D3665. The use of stratified random sampling procedure is important for the establishment of a valid certification program.

509.2.6 **Testing Requirements**

509.2.6.1 All certification testing required for this standard shall be performed by a laboratory holding current inspection and accreditation certificate from AASHTO Materials Reference Laboratory (AMRL). **COPIES OF ALL PROFICIENCY SAMPLE TEST REPORTS RECEIVED FROM AMRL, ALONG WITH ANY REQUIRED REMEDIATIONS SHALL BE PROVIDED TO UDOT.** For suppliers with multiple laboratories, satellite laboratories may be inspected by the supplier's primary AMRL inspected and accredited laboratory staff. The satellite laboratory(ies) must, however, participate in the AMRL Proficiency Testing Program.
The laboratory shall, at a minimum, be equipped with one Bending Beam Rheometer, one Dynamic Shear Rheometer, one Pressure Aging Vessel, one Brookfield Viscometer with Thermo cell , one Rolling Thin Film Oven, and one

Direct Tension Testing Device.

NOTE 3- Have primary laboratory facilities (test methods and equipment) regularly inspected by AASHTO Materials Reference Laboratory (AMRL). **A COPY OF THE AMRL REPORT ON THE LAB INSPECTION SHALL BE PROVIDED WITH THE TESTING RESULTS, ACCOMPANIED BY DOCUMENTATION OF RESOLUTION OF ANY DISCREPANCIES IN THE AMRL REPORT.** Cost of this inspection shall be borne by the source of data. Satellite laboratories may be inspected by the sources primary AMRL inspected and accredited laboratory staff. A copy of the source report of the satellite laboratory inspection shall be provided with the test report.

509.2.7 Supplier Requirements

509.2.7.1 The supplier shall submit annually, prior to the paving season, a written request to the agency for authorization to ship PGABs under the ASC system and shall list the grades to which the request applies. The written request shall be accompanied by 1-quart samples of each grade of PGAB with applicable certified test results covering all specification parameters. These samples shall represent actual formulations to be shipped during the season. Any subsequent formulation changes will require prior shipping approval. Although not mandatory, the applicable certificates should also state whether or not the binder was formulated with acid, the type and percentage of acid, and the type and percentage of polymer. UDOT will hold this information in strict confidentiality.

509.2.7.2 The agency (or its representative) shall have access at all times to the supplier's production/shipping facility, to inspect the facility, to observe the supplier's quality control procedures, to obtain samples. and to perform tests.

509.2.7.3 The supplier shall submit to the agency, for approval, a complete quality control (QC) plan which complies with the requirements of **Section 509.2.8**

509.2.7.4 The supplier shall follow the procedures set forth in the approved QC plan.

509.2.7.5 The supplier shall establish and maintain a daily record of all tests required on each grade included in the written request prepared to satisfy the requirements of **Section 509.2.7.1**. This record, if requested, shall be made available to the agency. In addition, the supplier shall forward with the written request, a one liter sample of each grade of PGAB to the agency.

509.2.7.6 The supplier shall submit all reports required by this standard in a format approved by the agency.

509.2.7.7 The supplier shall have a satisfactory record of compliance with specifications.

509.2.8 Supplier Quality Control (QC) Plan (Minimum Requirements)

509.2.8.1 The supplier QC plan shall identify:

509.2.8.1.1 the type of facility (i.e., refinery, terminal, etc.)

509.2.8.1.2 the location of the facility,

509.2.8.1.3 the name(s), and telephone number(s) of the employee(s) responsible for quality control at the facility,

509.2.8.1.4 the Quality Control (QC) tests to be performed on each PGAB, and

509.2.8.1.5 the laboratory(ies) performing quality control tests on the binder(s) that are shipped.

509.2.8.2 The supplier QC plan shall include a declaration stating that if a test result indicates non compliance of any shipment with the purchase specifications, the supplier shall (1) immediately notify the agency of the shipment in question, (2) identify the material, (3) cease additional shipment until material is brought back to specification, (4) notify the agency when shipment shall resume, (5) implement any mutually agreed-upon procedures for the disposition of the non compliance material.

509.2.8.3 The supplier QC plan shall describe protocols and frequency for initial testing, QC testing, and specification compliance testing.

509.2.8.3.1 Initial Testing- For each binder grade to be supplied, specification compliance testing (complete AASHTO M320 testing including AASHTO T-301 or ASTM D5801) shall be performed for at least three consecutive lots. The lot size will be agreed to by the supplier and the agency. A lot is a fixed batch of material. The agency must approve any change to lot sizes.
NOTE 4- In a batch operation used to manufacture the binder, a tank may be defined as a lot. The lot size would be the amount of material batched into the tank (e.g. 100 tons). Do not produce modified binders at the hot-mix production site. Modified binders shall be produced at a refinery or terminal.

509.2.8.3.2 Reduced test frequency for specification compliance- If approved by the agency, the frequency of testing for specification compliance can be reduced to every other lot if the individual AASHTO M320 and ASTM D5801 or AASHTO T-301 test result for every sample of the initial testing meets the following compliance criteria:

Original DSR, G*/Sin δ, 1.22 kPa
Original DSR,G*, 1.56 kPa
Phase angle (rule of 92), 71º
Phase angle (rule of 98), 68º
Original DSR, G*/sin δ, 1.65 kPa
RTFO DSR, G*/Sin δ, 2.68 kPa
PAV DSR, G*(Sin) δ, 3.9 Mpa
S BBR, 250 Mpa

m-value BBR, 0.312
Failure Strain Direct Tension ≥ 2.0%
Failure Stress Direct Tension, 5.2 Mpa
Toughness, 100 lb-in
Tenacity, 70 lb-in
Elastic Recovery of RTFO Res,
(Specified 65% min), 70 %
Elastic Recovery of RTFO Res
(Specified 70% min), 75%
Elastic Recovery of RTFO Res
(Specified 75% min), 80%

NOTE 5- The compliance criterion for Failure Stress and Strain in the Direct Tension Test is for those PG Grades having an algebraic difference between the high and low design grade of 92 °C or greater. G* denotes the complex modulus.
NOTE 6 - The compliance criterion for toughness and tenacity or elastic recovery is for grades having an algebraic difference of 92 °C or greater between the high and low temperature.

With the approval of the agency, the frequency of testing can be further reduced as long as the individual test results continue to meet the above compliance criteria.

If any of the criteria is not met, or if testing is resumed after occurrence of a non-compliance incident or after a plant shut-down, every lot will continue to be tested for the individual AASHTO M320 or ASTM D5801 property until three consecutive lots meet the above compliance criteria.

509.2.8.3.3 Minimum frequency - Complete AASHTO MP320 Specification compliance testing including ASTM D5801 or AASHTO T-301 shall be run at least once a month for each binder grade produced during that month. This minimum frequency is independent of the test results specified in **Section 509.2.8.3.2**

509.2.8.3.4 Quality Control testing guidelines for manufacturer- At least two AASHTO M320 test shall be used for monitoring high and low temperature properties of the binder. Manufacturers may use Non-AASHTO M320 tests approved by the agency. The use of non- AASHTO M320 tests does not preclude the need to meet AASHTO M320 specifications or to run complete AASHTO M320 tests according to the guidelines in **Section 509.2.8.3**

509.2.8.4 The QC plan shall include a statement that the supplier, if requested by the agency, shall prepare and submit quarterly summary reports of all quality control and specification compliance tests performed during that period.

509.2.8.5 In order to prevent contamination of shipments, the supplier QC plan shall provide an outline of the procedure(s) to be followed for inspection of transport vehicles prior to loading. The procedure shall include an entry stating that the transport vehicle inspection report, signed by the responsible inspector, shall be maintained in the supplier's records

and will be made available for review by the purchaser/agency upon request.

509.2.9 **Agency Requirements**

509.2.9.1 The agency shall review the QC and may visit the shipping site.

509.2.9.2 The agency, upon receipt of the application for **ASC** status, shall review the application, and if acceptable, notify the supplier of its approval. The notification shall include a listing of the grades covered.

509.2.9.3 The agency shall verify that the supplier's primary testing laboratory has current AASHTO accreditation and participates in the AMRL proficiency sample testing (**NOTE 3**)

509.2.9.4 The agency shall authorize shipment of each listed performance graded binder under the ASC system only after all requirements of the ASC have been satisfied.

509.2.10 **Requirements for Shipping PGABs by an ASC Supplier**

509.2.10.1 The supplier shall ship PGAB shipments covered by the certification as dictated by shipping schedules (i.e. at any time). Refer to section 509.2.7.1.

509.2.10.2 Each shipment shall be accompanied by two copies of the shipment bill of lading which shall include (1) the name and location of the supplier, (2) the grade of the material, (3) the quantity of the material shipped, (4) the date of the shipment, (5) a statement certifying that the transport vehicle was presented by the carrier acceptable for the material shipped. Each shipment shall also be accompanied by a complete Material Safety Data Sheet (MSDS) as required by the Code of Federal Regulations.

509.2.10.3 If the specification compliance test results do not conform to the PGAB specifications, the supplier shall remove the non conforming material from the shipping queue as outlined in **Section 509.2.8.2.**

509.2.11 **Split Sample Testing**

509.2.11.1 The agency may test split samples that are obtained at random from the Supplier's facility.

NOTE 7- Split samples shall be obtained from the same general locations from which the Supplier's **samples are taken.**

509.2.11.2 The agency shall determine the frequency of split sample testing. At least one split sample shall be taken and tested every 60 days.

509.2.11.3 If the split sample data and the Supplier test data are not within the following tolerances, (percent difference from the average) an immediate investigation shall be conducted to determine the cause of the difference between the data:

Original DSR: ±10%
RTFO DSR: ± 11%
PAV DSR: ± 23%
Original phase angle 2
s (60 sec), BBR: ± 10%
m-value, BBR: ± 0.015
Failure Strain, DT: ± 30%
Failure Stress, DT ± 20 %
Toughness ± 30%
Tenacity ± 30%
Elastic Recovery of RTFO Residue ± 10%

Unless available facts indicate otherwise, the investigation shall include a review of sampling and testing procedures of both supplier and agency.

509.2.12 **Report and Data Sheets**

509.2.12.1 The supplier shall submit all reports in accordance with the procedure described in **Section 509.2.7.6.** The test results shall be reported in a format that can be easily understood by a technician with minimum training in performance graded binder testing. The system of unit used shall be clearly stated. If test results are presented in a tabular format, the units, where applicable, shall be stated either as part of a column heading or after the description of the physical parameter or after its numerical value. The supplier shall also furnish the raw test data in a floppy diskette either in an ASCII format or in any commonly used spreadsheet format upon request by the agency.

509.2.13 **Withdrawal of ASC Status**

509.2.13.1 The agency may revoke or suspend ASC status under the following conditions:

509.2.13.1.1 The test data provided by the supplier to the agency does not meet the tolerances shown in. Section 509.2.11.3 for three consecutive samples.

509.2.13.1.2 Supplier test data can't be verified repeatedly by the agency and the agency deems that it is due to negligence on the part of the supplier.

509.2.13.1.3 The supplier is not following the approved QC plan.

509.2.13.1.4 A visit by the agency's representative to the supplier's facility reveals significant quality control problems.

509.3 Field Quality Control of PGAB

509.3.1 The field quality control of PGAB will be the responsibility of the contractor. Prior to accepting deliveries of PGAB, the contractor will submit a PGAB Quality Control Plan including minimum key elements as listed in Section **509.3.4 .** This plan will be included within the

contractor's quality control plan for asphalt concrete or and addendum to it. If the contractor is not using a quality control plan for asphalt concrete, the PGAB quality control plan will be a separate document which is an extension of the project contract. The quality control plan will be submitted at least 15 days prior to commencing paving operations. The purpose of the quality control plan is to describe proper handling techniques for the PGAB to ensure its consistency through transportation and storage operations. The quality control plan will be reviewed by the Project Engineer and paving operations will not begin before the plan has been accepted.

509.3.2 The contents of the PGAB quality control plan shall be contract specific and current to the production and mixture operations. Prior to executing any change to PGAB production, the quality control plan will be revised by written addendum to incorporate the change. Acceptance of the addendum will be required before the change is made to PGAB production. Failure to keep the quality control plan current may affect subsequent decisions, such as those made during failed material reviews and/or the appeal process.

509.3.3 The supplier that manufactures the binder and assigns the designated PGAB must be on UDOT's Approved Supplier Certification System (ASCS).

509.3.4 **Minimum General Requirements of the Contractor**'s **PGAB Quality Control Plan**

509.3.4.1 The quality control plan will have a signature page. The contractor and any subcontractor responsible for handling the PGAB will sign and date such page when the plan is submitted for acceptance.

509.3.4.2 The responsibilities of each party having a role in the quality control plan shall be identified.

509.3.4.3 The commitment towards communicating with UDOT personnel will be stated. Specific circumstances and arrangements for communication shall be identified as appropriate throughout the plan.

509.3.4.4 The anticipated mode of PGAB delivery will be outlined. The process of truck inspection prior to filling will be described to avoid binder contamination. Any sampling and testing to be conducted after delivery will be fully described.

509.3.4.5 The capacity(ies) and methods of agitation within the storage tank(s) will be described. Based on the type of asphalt used to produce the specific grade (i.e., blended asphalt, modified asphalt, etc.), any potential limitations of the PGAB relative to prolonged storage, exposure to prolonged and/or elevated heating, susceptibility to stratification and/or separation, etc. will be fully described.

509.3.4.6 Any special handling or storage requirements of the PGAB will be fully described. Any on-site sampling and testing will be outlined as to location, testing, and control limits.

509.3.4.7 The plan will identify procedures for identifying the PGAB contained in each storage tank.

509.3.4.8 The procedure to continually monitor and record the tank(s) temperature(s) will be described.

509.3.4.9 The procedure to change from one PGAB grade to another grade within a tank will be described.

509.4 Performance Graded Asphalt Binder Quality Assurance Plan

509.4.1 UDOT Sampling

509.4.1.1 Each day that asphalt concrete is being produced, a binder sample, comprised of three (3) individual one (1) quart containers will be taken at random times from the mix plant's asphalt tank injection line. CAUTIONS GIVEN: A UDOT inspector must witness the sample being taken. See Section 509.4.1.3.4 . Two of these containers will be for UDOT's use and the other container will be given to the contractor. The contractor will retain these samples until project completion. Each sample will be taken from the sampling valve after sufficient amount of binder is run out and wasted, in order to clear any residual asphalt and/or solvent that may build up in the sampling valve. It is the Contractor's responsibility to dispose/recycle accumulated wasted binder in a manner that will satisfy EPA requirements. Each sample will be taken at random times during the production day as determined by UDOT.

509.4.1.2 If mix plant operations are suspended for more than 48 hours, the next binder sample will not be taken randomly; instead, this binder sample will be taken at the resumption of operations.

509.4.1.3 Lots and Sublots

509.4.1.3.1 Each day's production shall constitute a binder sublot (represented by one random sample) and each week's production shall constitute a binder lot. A lot, however, will not exceed eight (8) sublots. thus the tonnage of binder may vary from sublot to sublot and from lot to lot. If two (2) production sublots or less are accumulated within a production week, this will not be considered a binder lot. These sublots will be included within the next production week. Thus, a binder lot shall consist of at least three (3) sublots.

509.4.1.3.2 A binder sublot shall include only one grade. Thus, if the grade is changed within a production day, that day will be divided into sublots representing each grade used and one binder sample will be taken for each grade used.

509.4.1.3.3 At the end of the project, the final binder lot may include less than three sublots.

509.4.1.3.4 All sublot samples will be sampled and/or witnessed by a representative of the contractor and a UDOT inspector. At the time the sample is taken, a sample identification form will be signed by both parties, signifying each sample's acceptability. UDOT will take control of its portion of the sample once obtained. The contractor will take control of and retain its portion of the sample as per

Section 509.4.1.1.

509.4.2 UDOT Testing

509.4.2.1 UDOT's AASHTO accredited laboratory will randomly choose one (1) sublot from each lot, and either completely or partially test the selected sample at its discretion. If the tested grade complies with the specified grade, the binder lot will be accepted. If the grade does not comply with the specified grade, the Resident Engineer will be notified of the failure by means of a test report . This test report will also be sent by registered mail to the Binder Supplier. ***THE TEST REPORT WILL REFERENCE THE FIRST SENTENCE OF SECTION 509.4.2.2.1.*** A price reduction will be assessed or the material will be removed and replaced as specified in Section 509.5.

509.4.2.2 **Guidelines for Appeal Procedure**

509.4.2.2.1 If the contractor wishes to appeal the test results of a lot, the contractor shall submit a written appeal request within 21 calendar days of *NOTIFICATION FROM THE ENGINEER.* The appeal must state the grounds or the circumstances of the appeal and if the test results are in-question, the appeal must be accompanied by all of the quality control test results that represents the lot in question. The contractor's retained and disputed sublot sample/s (see Section 509.4.1.1) must also be submitted to UDOT. This sample will be tested by an AASHTO accredited laboratory, independent from the supplier and contractor, and mutually acceptable to the contractor and UDOT. The contractor will be responsible for testing. The contractor will be held responsible for all penalties assessed if the contractor's part of the sample can't be furnished. The binder supplier is not to be held liable in this case.

509.4.2.2.2 The appeal request and the submitted test results will be reviewed by UDOT. If the appeal has merit and the contractor's binder test results from the mix plant (see section 509.4.2.2.1) indicate a significant difference between UDOT's binder test results, the appeal will be accepted by UDOT.

509.4.2.2.3 When an appeal is accepted, the agency will conduct additional binder tests on two(2) additional sublot samples from the lot in question. The two additional sub-lot samples will be randomly chosen and will be tested for those test parameters that significantly differ between UDOT and the contractor. Any invalid test results will be disregarded. The initial and additional test results for each test will be averaged and the average value for each test will be considered the final lot value. Thus, the final lot values will be used to determine compliance or non-compliance.. Compliance or non-compliance will be acted upon as outlined in **Section 509.5**. The contractor will be notified in writing of the additional test results, the final lot values, and the appeal conclusions.

509.4.2.2.4 If the appeal is not accepted, UDOT will submit a denial letter to the contractor, stating the grounds for the denial.

509.4.2.2.5 The contractor may request referee testing on the assessed price reductions from Section 509.4.2.2.3. The contractor will agree to have the available back-up sublot samples retained by UDOT, from the lot in question, tested by an AASHTO accredited laboratory mutually acceptable to the contractor and UDOT. All specification parameters in contention will be tested on each sublot sample. The contractor will agree to bear the costs of testing each sublot sample if the referee tests verify non-specification compliance on any one sublot sample. UDOT will bear the costs of testing if all sub-lot samples are in compliance to the specifications. The AASHTO accredited laboratory will report the results to UDOT. The results of the tests will be binding to both parties. These test results for the test parameter(s) in contention will be averaged. This average value(s) will be considered the final lot value. This final lot value(s) will be used to determine compliance/non-compliance to the specifications as outlined in Section 509.5.

509.5 Calculation and Application of Price Reductions for Non-Specification PGAB

509.5.1 Table 1. Compliance and rejection limits for price rejection calculations for PGAB.

Property	Compliance Limit for Price Reduction of 0 %	Rejection Limit Price Reduction 25 %
G*/sinδ of the original PGAB at high grade temp, (kPa)	**0.84 Min.**	**0.70 Min**
G* of the original PGAB at high grade Temperature, (kPa)	**1.25 Min**	**1.11 Min**
δ (phase angle) of the original PGAB at high grade Temp.	**75.0 Max**	**77.0 Max**
δ (phase angle) of the original PGAB at high grade Temp. (Rule of 98) degrees	**72.0 Max**	**74.0 Max**
G*/Sin δ or RTFO Residue at high temperature, (kPa)	**1.87 Min**	**1.53 Min.**
Stiffness of the PAV residue at Low Grade temp. + 10º C, (Mpa)	**311 Max**	**355 Max**
Slope (m-value) of the Creep Curve at Low Grade temp. +10º C	**0.295 Min**	**0.266 Min**
Failure Strain of PAV	**1.4 Min**	**1.2 Min.**

Property	Compliance Limit for Price Reduction of 0 %	Rejection Limit Price Reduction 25 %
Residue in Direct Tension at Low Grade Temp. + 10° C[1], %		
Failure Stress of PAV Residue in Direct Tension at Low Grade Temp. + 10°C [1] , Mpa	**4.0 Min**	**3.5 Min**
Toughness of original PGAB , lb. in [1]	**68 Min**	**49 Min**
Tenacity of original PGAB, lb in. [1]	**45 Min**	**32 Min**
Elastic Recovery of RTFO Residue [1], (specified min. of 65%) **(specified min. of 70%)** **(Specified min. of 75%)**	**60 Min** **65 Min** **70 Min**	**50 Min** **55 Min** **60 Min**

[1] Use only for binders whose high and low temperature algebraic difference is 92 ° C or greater

509.5.2 If the value of the measured properties meet the compliance limit of table 1, the price reduction is 0% for each individual test property. The price reduction for each individual property will be 25% at the rejection limit. If any measured property is outside the rejection limit, i.e., greater than 25%, the mixture will be rejected. For each property whose value lies between the compliance limit and the rejection limit, the price reduction will be calculated assuming a linear variation between 0 and 25. For example, if the measured m value is 0.270, the per cent price reduction for the m-value will be calculated as follows:

$$\% \text{ Price Reduction for m - value : } \quad 25 \times \frac{(0.295 - 0.270)}{(0.295 - 0.266)} = 21.6$$

509.5.3 For a particular sample having more than one parameter out of specification, the composite price reduction for the PGAB will be calculated by summing the reduction of each individual property calculated as described above.

509.5.4 The PGAB shall be accepted with reduced composite price reduction if none of the critical properties are outside the rejection limit and the composite price reduction is 25% or less. The material will be rejected if one or more of the measured properties fall outside the rejection limit or if the composite price reduction is more than 25%.

509.6 Basis of Payment

509.6.1 The amount of price reduction made to the contractor will be based on the hot mix asphalt price

quoted in the contractor's bid. If the price per ton is un-balanced then the applicable previous year average bid price per ton will be used.

Price Reduction = Line item price for HMA x PRPGAB x Number of tons HMA